FIGURE D79–5—SATURATION VAPOR PRESSURE OVER WATER (PASCALS)—Continued

Temperature °C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
12	1402.17	1411.45	1420.78	1430.16	1439.60	1449.10	1458.64	1468.25	1477.91	1487.62
13	1497.39	1507.22	1517.11	1527.05	1537.04	1547.10	1557.21	1567.39	1577.62	1587.90
14	1598.25	1608.66	1619.12	1629.65	1640.24	1650.88	1661.59	1672.36	1683.18	1694.08
15	1705.03	1716.04	1727.12	1738.26	1749.46	1760.73	1772.06	1783.45	1794.91	1806.43
16	1818.01	1829.67	1841.38	1853.17	1865.02	1876.93	1888.91	1900.96	1913.08	1925.27
17	1937.52	1949.84	1962.23	1974.69	1987.21	1999.81	2012.48	2025.21	2038.02	2050.90
18	2063.85	2076.87	2089.97	2103.13	2116.37	2129.68	2143.07	2156.53	2170.06	2183.66
19	2197.34	2211.10	2224.93	2238.84	2252.82	2266.88	2281.02	2295.23	2309.52	2323.89
20	2338.34	2352.86	2367.47	2382.15	2396.91	2411.76	2426.68	2441.68	2456.77	2471.93
21	2487.18	2502.51	2517.93	2533.42	2549.00	2564.66	2580.41	2596.24	2612.16	2628.16
22	2644.25	2660.42	2676.68	2693.02	2709.46	2725.98	2742.59	2759.28	2776.07	2792.94
23	2809.91	2826.96	2844.11	2861.34	2878.67	2896.09	2913.60	2931.20	2948.89	2966.68
24	2984.56	3002.54	3020.61	3038.77	3057.03	3075.39	3093.84	3112.39	3131.03	3149.78
25	3168.62	3187.55	3206.59	3225.73	3244.96	3264.30	3283.73	3303.27	3322.91	3242.65
26	3362.49	3382.43	3402.48	3422.63	3442.89	3463.24	3483.71	3504.28	3524.95	3545.73
27	3566.62	3587.62	3608.72	3629.93	3651.25	3672.67	3694.21	3715.86	3737.61	3759.48
28	3781.46	3803.55	3825.75	3848.07	3870.50	3893.04	3915.70	3938.47	3961.36	3984.36
29	4007.48	4030.71	4054.06	4077.53	4101.12	4124.83	4148.65	4172.59	4196.66	4220.84
30	4245.15	4269.58	4294.13	4318.80	4343.60	4368.52	4393.56	4418.73	4444.02	4469.44

§ 86.345–79 Emission calculations.

(a) The following abbreviations (and units) are used in this section.

α = atomic hydrogen/carbon ratio of the fuel

ϕ = dry fuel-air ratio (measured)/fuel-air ratio (stoichiometric)

BARO = Barometric pressure (in. *H* g*A*)

BHP = Brake horsepower

BSCO = Brake specific carbon monoxide emissions, (gm/*BHP-HR)*

BSFC = Brake specific fuel consumption (lb/*BHP-HR*)

BSHC = Brake specific hydrocarbon emissions (gm/*BHP-HR*)

$BSNO_X$ = Brake specific oxides of nitrogen emissions (gm/*BHP-HR*)

DCO = CO volume concentration in exhaust, ppm (dry)

DCO_2 = CO_2 volume concentration in exhaust, percent (dry)

DHC = HC volume carbon concentration in exhaust, ppmC (dry)

DKNO = NO volume concentration in exhaust, in ppm (dry and humidity corrected)

EIP = engine intake pressure (in. *H* g*A*) = *BARO* − inlet depression

f/a = measured dry fuel-air ratio

G = humidity of the inlet air in grains of water per pound of dry air = (453.59/0.0648) *H*, (see § 86.344)

K = water − gas equilibrium constant = 3.5

K_{NOx} = Humidity correction factor for oxides of nitrogen

K_w = Wet to dry correction factor

M_C = Atomic weight of carbon

(M_C + M_H) = mean molecular weight of the fuel per carbon atom

M_{CO} = Molecular weight of CO

M_F = Mass flow-rate of fuel used in the engine in lb/hr = W_f/453.59

M_H = Atomic weight of hydrogen

$M_{NO}2$ = Molecular weight of nitrogen dioxide (NO_2)

T = Temperature of inlet air (°F)

W_{CO} = Mass rate of CO in exhaust, grams/hr

W_f = Mass flow-rate of fuel used in the engine, in grams/hr = (453.59) x (W_f lbs/hr)

WHC = HC volume concentration in exhaust, ppm *C*(wet)

W_{HC} = Mass rate of HC in exhaust, grams/hr

W_{NOx} = Mass rate of NO_X in exhaust, grams/hr

Y = H_2O volume concentration of intake air (See § 86.344)

(b) Determine the exhaust species volume concentration for each mode.

(c)(1) Convert wet basis measurements to a dry basis by the following:

Dry concentrations = $1/K_W$ x wet concentrations. K^W is defined by the equation in Figure D79–6.

(2) For Diesel engines, for each mode use the measured engine (*f/a*) entering the combustion chamber when calculating ϕ. If applicable bleed air, etc. must be subtracted from the measured air flow (see § 86.313).

(3) For gasoline-fueled engines, optional for Diesel engines, calculate ϕ for each mode by substituting *WHC* for *DHC* in the (*f/a*) equations in paragraph (d) of this section.

(4) Calculate a *Y* value for each gasoline-fueled engine test from the pretest data. Apply the *Y* value to the K_W equation for the entire test.

(5) Calculate a separate *Y* value for each Diesel test segment from the pretest-segment data. Apply the *Y* value to the K_W equation for the entire test-segment.

$$K_W = \frac{1}{1+\left[\frac{\alpha\left(\frac{DCO_2}{10^2}+\frac{DCO}{10^6}\right)+\frac{2Y}{\phi}\left(\frac{DCO_2}{10^2}+\frac{DCO}{10^6}+\frac{WHC}{10^6}\right)\left(1+\frac{\alpha}{4}\right)}{2\left(1+\frac{\frac{DCO}{10^6}}{\left(\frac{DCO_2}{10^2}\right)K}\right)}\right]}$$

Figure D79–6. K_w—Wet To Dry Correction Factor.

(d) Compute the dry (*f/a*) if required as follows:

$$(f/a) = \frac{4.77(1+\alpha/4)(f/a)\,stoich}{\frac{1}{\overline{X}}-\left(\frac{DCO}{2\overline{X}(10)^6}\right)-\left(\frac{DHC}{\overline{X}10^6}\right)+\frac{\alpha}{4}\left(1-\frac{DCO}{\overline{X}(10)^6}\right)-\frac{.75\alpha}{\frac{K}{\frac{DCO}{\overline{X}(10)^6}}+\left(\frac{(1-K)}{1-\frac{DHC}{\overline{X}(10)^6}}\right)}}$$

Where

$$(f/a)stoich = \frac{M_C+\alpha M_H}{138.18(1+\alpha/4)}$$

$$\overline{X} = DCO_2/10^2 + DCO/10^6 + DHC/10^6$$

(e) *Data validation*—(1) *Diesel engines only.* Compare the calculated dry (*f/a*) with the measured fuel and air flow. For a valid test the emission calculated (*f/a*) must agree within 10 percent of the measured (*f/a*) for each mode. Diesel engine idle and 2 percent modes do not have to meet this requirement.

(2) *Fuel/Air ratio comparison.* When comparing measured (*f/a*) ratio to an emissions calculated (*f/a*) ratio, the measured air flow (in terms of mass) is the total mass of air entering the exhaust pipe. This may include additions of air mass to the exhaust pipe by an air injection system.

(3) Other methods of data validation may be used if prior approval is obtained from the Administrator.

(4) Data validation techniques that have obtained prior approval from the Administrator for use on gasoline-fueled engines may be used to determine void tests.

(f) Multiply the dry nitric oxide volume concentrations by the following humidity correction factor to obtain *DKNO:*

(1) Gasoline-fueled engines:

$K_{NOx} + 0.6272 = 0.00629G - 0.0000176G^2$

(2) Diesel engines:

$$K_{NOx} = \frac{1}{1+A(G-75)+B(T-85)}$$

where:

$A = 0.044\ (f/a) - 0.0038$

$B = -0.116(f/a) + 0.0053$

T = Temperature of inlet air, °F.

(g) Calculate the mass emissions of each species in grams per hour for each mode as follows:

$$(1) \qquad \text{HC grams/hr} = W_{HC} = \frac{(DHC/10^4)W_f}{(DCO/10^4) + DCO_2 + (DHC/10^4)}$$

$$(2) \qquad \text{CO grams/hr} = W_{CO} = \frac{M_{CO}(DCO/10^4)W_f}{(M_C + {}_\alpha M_H)[(DCO/10^4) + DCO_2 + (DHC/10^4)]}$$

$$(3) \qquad \text{NO}_x \text{ grams/hr} = W_{NOx} = \frac{M_{NO2}(DKNO/10^4)W_f}{(M_C +{}_\alpha M_H[(DCO/10^4) + DCO_2 + (DHC/10^4)]}$$

(h)(1) For gasoline-fueled engines, weight the mass values of *BHIP*, W_{HC}, W_{CO}, *Mf*, and W_{NO_x} for each mode by multiplying the modal mass values by the appropriate modal weighting factor prescribed by § 86.335.

(2) For Diesel engines, weight the values of *BHP*, W_{HC}, W_{CO}, W_{NO_x}, and *Mf* as follows:

(i) Weight the values from each idle mode by multiplying the values by (0.067);

(ii) Weight the remaining modes by multiplying the values by 0.08.

(i) Calculate the brake specific emissions for:

(1) Each gasoline-fueled engine test cycle, and

(2) Each Diesel engine test by summing the weighted values (*BHP*, W_{HC}, W_{CO}, and W_{NO_x}) from each mode as follows:

$$BSHC(t) = \frac{\sum \text{weighted } W_{HC}}{\sum \text{weighted } BHP}$$

$$BSCO(t) = \frac{\sum \text{weighted } W_{CO}}{\sum \text{weighted } BHP}$$

$$BSNO_x(t) = \frac{\sum \text{weighted } W_{NO_x}}{\sum \text{weighted } BHP}$$

(t) = Test cycle number (t = 1, 2) (gasoline-fueled engines only).

(j)(1) Calculate the brake-specific fuel consumption (*BSFC*) from the non-weighted *BHP* and *Mf* for each mode. Gasoline-fueled engine idle and *CT* modes, and Diesel idle modes are excluded.

(2) For gasoline-fuel engines use:

$$BSFC = \frac{M_f}{BHP}$$

(3) For Diesel engines use:

$$CBSFC = \frac{M_f}{CBHP}$$

where:

$$CBHP = BHP\left[\frac{29.00}{EIP}\right]\left[\frac{T + 459.69}{85 + 459.69}\right]^{0.7}$$

(4) Other methods of correcting power to determine *BSFC* may be used only with prior approval of the Administrator.

(k) Calculate the weighted brake-specific fuel consumption (*WBSFC*) for

(1) Each gasoline engine test cycle by:

$$WBSFC(t) = \frac{\sum \text{weighted } M_f}{\sum \text{weighted } BHP}$$

where:

t = Test cycle number (t = 1,2)

(2) Each Diesel engine test by:

$$WCBSFC = \frac{\sum \text{weighted } M_f}{\sum \text{weighted } CBHP}$$

(l) For gasoline-fueled engines, calculate the brake-specific emissions and fuel consumption for the complete test as follows:

$BSHC(T) = 0.35\ BSHC(1) = 0.65\ BSHC(2)$
$BSCO(T) = 0.35\ BSCO(1) = 0.65\ BSCO(2)$
$BSNO_x(T) = 0.35\ BSNO_x(1) = 0.65\ BSNO_x(2)$
$WBSFC(T) = 0.35\ WBSFC(1) = 0.65\ WBSFC(2)$

§ 86.346–79 Alternative NO_X measurement technique.

(a) Oxides of nitrogen (NO_X) may be measured with the following ''alternative instrumentation'' for both Diesel and gasoline-fueled engines. The ''alternative instrumentation'' shall consist of:

(1) A heated sample line maintained above the dew point:

(2) An NO_2 to NO converter obtaining a sample directly from the heated sample line; and

(3) A combination per 40 CFR 86.777 or 40 CFR 86.977, whichever is applicable of a water trap, dryer, flow controls, and an NO NDIR analyzer obtaining a sample from the converter.

(b) The provisions of 40 CFR 86 subpart D shall apply to the ''alternative instrumentation'', where applicable, with the following exceptions:

(1) Analyzer specifications found in §§ 86.315, 86.321, and 86.322 do not apply to the ''alternative instrumentation''.

(2) For the purposes of this section, the full-scale value specified in § 86.338 (a)(1) shall be 1,500 ppm for Diesel engines and 2,500 ppm for gasoline-fueled engines.

(c) The ''alternative instrumentation'' shall be calibrated per § 86.330.

(d) The NO NDIR analyzer shall meet the performance and interference specifications contained in 40 CFR 86.777 or 40 CFR 86.977, whichever is applicable.

(e) The operation of the dryer shall follow good engineering practice such that the test results are not altered. Proper preconditioning of the dryer is allowed.

§ 86.347–79 Alternative calculations for diesel engines.

(a) *This section applies to Diesel engines only.* Gasoline-fueled engines must use the calculations in § 86.345.

(b) For Diesel engines, the calculations specified in 40 CFR 86.977–15 may be substituted for § 86.345.

(c) The modal *BSFC* and weighted *BSFC* shall be calculated per § 86.345.

(d) If the provisions of this section are used, a CO_2 measurement is not required.

(e) Both 40 CFR 86.977–15(a) and § 86.313 shall apply to air-flow measurements. For the purposes of this section, the air-flow measurement accuracy specified in § 86.313 shall be ±1 percent.

§ 86.348–79 Alternative to fuel H/C analysis.

(a) Fuel H/C analysis need not be performed if the following average H/C ratios are used for all calculations.

(1) #1B1 Diesel: 1:93

(2) #1B2 Diesel: 1:80

(3) Gasoline: 1.85

(b) [Reserved]

[46 FR 50496, Oct. 13, 1981, and 47 FR 49807, Nov. 2, 1982]

Subpart E—Emission Regulations for 1978 and Later New Motorcycles, General Provisions

SOURCE: 42 FR 1126, Jan. 5, 1977, unless otherwise noted.

§ 86.401–90 General applicability.

(a) This subpart applies to 1978 and later model year, new, gasoline-fueled motorcycles built after December 31, 1977, and to 1990 and later model year, new, methanol-fueled motorcycles built after December 31, 1989.

(b) Motorcycles with engine displacements less than 50 cc (3.1 cu in) are excluded from the requirements of this subpart.

(c) Motorcycles are excluded from the requirements of this subpart, if with an 80 kg (176 lb) driver, it cannot:

(1) Start from a dead stop using only the engine, or

(2) Exceed a maximum speed of 40 km/h (25 mph) on level paved surfaces.

[54 FR 14539, Apr. 11, 1989]

§ 86.401–97 General applicability.

(a) This subpart applies to 1978 and later model year, new, gasoline-fueled motorcycles built after 31 December, 1977, and to 1990 and later model year, new, methanol-fueled motorcycles built after 31 December, 1989 and to 1997 and later model year, new, natural